"Putting Science to Work for Everyone"

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As delivered

Thanks, Jim, for having me here today.

It's great to be back in Denver. I grew up less than a mile from here and I have fond memories of visiting the museum, especially the habitat dioramas. For many years, my mom was a docent here, so my five sisters and I would eagerly await each new exhibit. And last night at dinner, my nieces and nephew described the new pirate and space odyssey exhibits with great enthusiasm. Clearly, the museum is inspiring and informing multiple generations.

This museum started with one man's love of nature. That man, Edwin Carter, was an early environmentalist. Edwin was a miner back in the mid-1800s. He observed first-hand the changes that mining had on the landscape and wildlife. So he began collecting animal and bird specimens as a record of the diverse wildlife in the area. His log cabin collection of 3,000 specimens became this museum.

Edwin Carter loved nature and he appreciated the complex connections between people and nature. I was fortunate to grow up hiking and camping in the Rockies, and I too became enamored with natural history and with science. When I discovered a big new place to explore- the ocean- I was even more intrigued. I fell in love with sea stars, squid, sea urchins, crabs, sponges, barnacles – all sorts of bizarre critters - each with a different solution to the common challenges of finding food, shelter and mates and avoiding being eaten. My love of science and the ocean turned me into a marine ecologist.

After I had been teaching and doing research and becoming a champion for science for decades, President Obama asked me to join his science team and lead the nation's agency for oceans and atmosphere – NOAA.

NOAA is the country's very first science agency. It was founded by Thomas Jefferson when he was president. Back in Jefferson's time, it was called the Survey of the Coast. The Survey created the nation's nautical maps and charts. NOAA continues that tradition today. In fact, NOAA still uses science to produce not only nautical charts, but indeed the mapping system that's used by GPS, an indispensible tool of our times.

At NOAA all things start with science.

Our scientists build and improve our understanding of how the world works and how it is changing. But we do so much more than that. But we do so much more than that. NOAA puts that science to work for everyone – each and every day. NOAA scientists use science to create and share trusted information and solutions to some of the greatest challenges on this planet: such as knowing when and where

severe storms will strike, testing seafood for safety, tracking and understanding climate change, using satellite to guide search and rescue operation, responding to oil spills, and working to restore oceans to a healthy state.

So, these may seem like a disparate collection of services and stewardship, but they center around oceans, coasts, climate and weather- and are all based on science. Today, I'm going to tell you some science stories – stories that show how NOAA puts science to work for you and the nation.

WEATHER FORECASTS

Let's talk first about weather forecasts.

Even though Coloradoans might find themselves switching on the heat and the A/C in the same day, you still rely on weather forecasts. Weather forecasts are everywhere – on your computer, your phone, your iPad, the radio, and TV. Click a mouse, swipe a finger, and, there it is: instant weather, 24/7.

Where do you think those weather forecasts originate? Not from a tv or a radio station or some website on the Internet. Weather forecasts come from NOAA.

Weather forecasts are predictions made from data that NOAA collects: data from observations made by satellites in space, planes and balloons in the air, radar on the ground, ships and buoys on the water, and gliders under the sea. Among these platforms, satellites loom large- >90% of the data that go into our numerical weather prediction models come from NOAA's weather satellites. And as an aside, we have great partners here in Colorado, who build those high tech satellites and instruments. Ball Aerospace in Boulder is building two of our weather satellites, as well as Lockheed Martin and Raythion.

Satellites and other platforms provide data about current global conditions. We feed those data into weather models, which crunch data to generate weather forecasts. That number crunching is no small feat – it uses some of the country's most powerful supercomputers available! NOAA produces data and forecasts and distributes it widely. At that point, the private sector weather industry (think the Weather Channel or AccuWeather, etc) tailors the information and sells it to specific users.

So your tax dollars provide both a public good- weather forecasts and warnings, and they provide opportunities for businesses. The private weather industry is now a multi-billion dollar industry.

So every time you use that weather app on your iPhone, hear it on the radio, or look at a weather radar map on the computer or tv, remember *that* weather report comes from NOAA science and NOAA scientists. NOAA science, products, and services were the innovations that built that industry. So, when you put innovative science to work for people, substantial economic dividends accrue for the entire country.

EXTREME WEATHER: HEAT WAVES

The nation is increasingly vulnerable to extreme weather. And this year has been a year of record breakers. Every State has set a heat record this year. In July alone, Colorado broke or tied 50 heat records, including 23, 100+ degree records. In the first half of August, preliminary analysis shows a whopping 5,000 heat records were broken. 2000 of those were record high maximums, and 3,000 were for a record high minimum. Night time temperatures are getting warmer.

Here in Colorado you've had a mild heat wave, but elsewhere the heat wave has been intense. At the peak of the heat wave in July, 147 million Americans were under a heat advisory or warning-roughly half

of the US.

The heat made drought conditions worse in many areas of the country at the end of July 26% of the lower 48 was in severe to extreme drought.

Every year, more people die in heat waves than in hurricanes, tornadoes, floods, and earthquakes combined (CDC). Heat wave forecasts save lives. And this year, NOAA has been exceptionally busy. NOAA forecasts heat waves about two weeks before they happen. When a city hears that a heat wave is coming, it prepares cooling centers to protect people who don't have a way to keep cool.

We feel the heat. We crank up the AC. The demand for electricity strains the city's power capacity. With advance heat wave warnings, cities can plan for the extra demand on the power grid. Hospitals make contingency plans knowing that brownouts may occur. By giving advance warning, NOAA forecasts help people and communities prepare for extreme weather events. Imagine what would happen without them.

This heat is wreaking havoc with farming and with wildfires. A new record has been set for the January to end of July period, with 6.1million acres burned. But the pattern is more complex. This is a tale of 2 countries- hot and dry in some places, super wet elsewhere. I mentioned earlier that at the end of July, 26% of the lower 48 was in severe to extreme drought. At the same time 33% of the country was severely hot. Among the many statistics that NOAA tracks are the numbers of severe weather events- hurricanes, tornadoes, snow storms, floods, etc. that total $1Billion or more. The previous record number of '$1Billion events' was set in 2008. 2011 has now tied 2008 with 9 $1Billion events, and we are only 8-months into the year with peak hurricane season looming.

The good news is that through investments in research, NOAA has vastly improved its ability to predict these extreme events; the bad news is that with climate change underway, we'll likely see continued increases in severe storms and drought and heat waves.

Science has made amazing improvements in weather forecasts in a relatively short period of time. Since 1990, NOAA's hurricane track error – a hurricane's track is its projected path - has decreased 60 percent since 1990. Over the past 20 years, tornado warnings have gone from a 5-minute advance warning to a current average of 15 minutes. Today, long-term seasonal forecasts for river flooding and drought are made.

In parallel to working to reduce greenhouse gas emissions and providing outlooks so communities and businesses can plan, NOAA is partnering with emergency managers to achieve a weather ready nation, where communities are prepared and citizens have options and information when disaster strikes.

NOAA IS MORE THAN WEATHER

Weather is the most visible of what NOAA does, but there is an 'O', not just an 'A' in our name. The "O" stands for our ocean responsibilities, and they are intimately connected and affect each other as well as us. We've improved our weather forecasts because research has shown us that oceans are integral to weather forecasts. For instance, ocean temperature and salinity are critical components of hurricane forecasts. And now we know that oceans play a critical role in regulating the Earth's climate. The Earth is an integrated system.

One of the big changes I've noted in returning to Denver over the years has been the availability of fresh seafood. When I was growing up, seafood was mostly canned tuna. Seafood, is popular here and

there is increasing recognition of the importance of eating sustainably-caught and sustainably-farmed seafood. Sustainable fisheries and sustainable aquaculture are two of NOAA's key responsibilities, along with the charge as the steward of healthy oceans and coasts.

And science underpinning our work there as well.

NOAA IS LIKE A MUSEUM

In addition to providing forecasts and warnings, navigation maps, search and rescue, and managing fisheries, NOAA is a living repository of data- not unlike a museum.

NOAA is the collector and curator of the nation's historic and current weather records – much like the Denver Museum of Science and Nature collects and curates specimens. The tradition of collecting and curating weather records in the U.S. started in the 1800s at the Smithsonian. Long-term records form the basis for the Earth's climate record.

WATER RESOURCES

We use these records and the models built on them to help communities plan for the future. The city of Boulder wanted to understand the impacts of climate change on its water supply. So the city along with NOAA scientists, federal agencies, and university researchers conducted a scientific study using local climate records and climate model projections to manage their water future.

RENEWABLE ENERGY

And, speaking of the future- we are working avidly to support, a future where most of our electricity comes from renewable energy sources. In May, President Obama released the *Blueprint for a Secure Energy Future*. The *Blueprint* sets a goal of 80 percent of electricity coming from clean energy sources by 2035.

Weather forecasts will play a critical role in making affordable wind and solar energy happen.

Let's focus on wind first. Wind is one renewable energy option. But wind isn't constant; it comes and goes. When the wind calms down, the grid has to fill in some other energy source has to take over.

One thing we know for sure is wind producers need better predictions for what the wind's going to do. Energy producers need wind forecasts a day ahead of production. If 20 percent of U.S. electric needs are met by wind energy, wind forecasts made a day ahead would save the industry an estimated $1-$4 billion per year.

Right now, NOAA is doing the scientific research to move us toward day-ahead wind forecasts – forecasts where we know when and how hard the wind will blow. We're in a good position to accomplish this. We have the right tools, the right expertise, and the right partners to do this research. And we're doing this research in the right place – rural areas where there are wide swaths of open land. Our partners span other federal agencies, industry, and academic researchers. Ultimately, this research will make wind energy affordable for most everyone.

Multiple sectors will benefit from this research. The wind data will be fed into high resolution weather models that are used for research. Ultimately, wind energy research will yield better weather forecasts.

For solar energy, we're in pretty much the same situation. We have sunny days, cloudy days, and

outright gloomy days. Clouds come and go. We need better cloud forecasts for the same reason we need better wind forecasts.

CONCLUSION

I've talked primarily about the atmospheric side of NOAA. Just as atmospheric data, observations, and models are the workhorses for NOAA's weather forecasts, we also collect a wide range of data from the ocean, studying oceanic processes and ecosystems and exploring its unknown depths.

From the bottom of the ocean to the surface of the sun, NOAA collects, curates, and uses a large proportion of this nation's share of the data about the Earth. NOAA puts its vast collection of information about the weather, climate, oceans, coasts, and the atmosphere to work for everyone every day. This is NOAA's value to the nation.

If you want to catch a glimpse of NOAA's museum of the Earth, join me on a tour of Science On a Sphere® after the talk. Science On a Sphere was invented by NOAA's Boulder Lab director, Dr. Sandy MacDonald.

In closing, I want to leave you with the message I started with: Science plays a pivotal role in our lives every day. All things NOAA start with science.

For less than a nickel a day, per person per year, NOAA puts that science to work for every American providing essential services:

Like healthy oceans.

Like severe weather forecasting, warnings and research.

Like disaster preparedness, and oil spill response and habitat restoration.

Like seafood safety testing and satellite-aided search and rescue.

One of the best bargains in the country!

Using science, we develop solutions for a sustainable future– a future with natural resources that our families, our grandchildren, and generations to come can enjoy and use, if we use them wisely first.

CLOSING REMARKS (after Q&A)

Every day, Americans rely on essential services from NOAA – essential services that start with science - services that impact families, communities, and people.

And in your community: Ball Aerospace out in Boulder building NOAA weather satellites, NOAA's Earth System Research Laboratory, also in Boulder, and the NWS Weather Forecast Office right here in Denver. There is also Lockheed Martin, and Raytheon.

As we look to the future– a time of continuing budget constraints - it will be increasingly difficult to maintain the services and advance the science to meet the needs of the nation.

Despite these difficulties, we are in a time when people are empowered to make small changes in their lives that can make great changes for the world.